The eHealth Landscape: A Terrain Map of Emerging Information and Communication Technologies in Health and Health Care

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We now have access to the largest volume of health information in history. People can seek support and advice from potentially millions of online peers and professionals worldwide at any time of day. Using the Internet, they can assess their health risks, fill a prescription, manage a chronic condition, decide on treatment regimens, and consult a health care provider without leaving their home. Emerging information and communication technologies promise to usher in a wealth of innovative solutions for seemingly intractable problems in health and health care, including quality, access, and cost.

Against this backdrop of unprecedented technological innovation, many aspects of the health and health care systems are in need of serious attention. These systems are ripe with inefficiencies, inequities, and errors. The United States spends more on health care than any other country, yet more than 44 million Americans do not have health insurance. In addition, between 44,000 and 98,000 people may die every year as a result of medical errors, and variations in medical practice may result in uneven patient outcomes. Increasingly, people perceive that they are ceding control of their health care decisions to institutions that have placed financial priorities above individual health needs. Although Americans have recently made inroads in some behavior-linked conditions, such as tobacco use and teen pregnancy, other health problems, such as physical inactivity and obesity, are at epidemic levels.

eHealth is the use of emerging information and communication technology, especially the Internet, to improve or enable health and health care. This term bridges both the clinical and nonclinical sectors and includes both individual and population health-oriented tools.

This overview of the eHealth sector addresses the following questions: What is the emerging field of eHealth? Who are the major players in this dynamic arena? What are the major eHealth issues? And, what are the emerging trends and technologies on the immediate horizon that will shape future eHealth tools?

Current Status of the eHealth Sector

In January 2001, approximately 168 million (60 percent) of the total U.S. population had access to the Internet at home or work, and as many as 86 percent of adult Internet users accessed it to research information on health care or specific diseases. The number of health-related Web sites available is unknown, but it is widely believed that the more than 19,000 health sites indexed on Yahoo! as of May 2001 represent only a small fraction of the universe of eHealth sites. Although populations that have been traditionally underserved are less likely to have Internet access, the profile of Internet users is shifting from one comprised initially of largely white, educated, young men to a much more diverse group of users.

Compared to other industry sectors, such as finance and commerce, the adoption and integration of information technology in the health sector is unfolding much more slowly. As with most other Internet-related sectors, the eHealth field is being driven primarily by for-profit eHealth companies. At present, many of the most recognized eHealth companies are consumer-oriented portals that seek to be "one-stop shops" for health information and health-related products. The most common focus of larger eHealth companies seems to be on providing tools, solutions, products, or services that support some aspect of clinical care or eCommerce, including administrative transactions, clinical information systems, telemedicine and telehealth, and sales of health-related products. With the exception of providing consumers with health information, few companies are focused on population-oriented eHealth tools partly because of perceptions about the viability and scope of this market segment.

Business models employed by eHealth entities include advertising, sponsorship, merchant, transaction fee, licensing, fee for service, clinical services, data and
infomediary, and subscription models. In practice, many companies rely on a combination of revenue streams. Many commercial eHealth companies face an uncertain future as eHealth business models are still evolving. In addition, the long-term outlook for publicly traded eHealth companies is unclear, but the recent Internet stock market correction suggests that fewer eHealth companies will be
going public in the next few years, and that venture capital will be more difficult to obtain.

As with other Internet-related sectors, the status of the eHealth arena is extremely fluid and characterized by rapid developments in the commercial and noncommercial sectors. During the last few years, traditional ("bricks and mortar") health corporations, which were initially slow to embrace the Internet, have become increasingly active in Internet-related ventures. As with many other sectors, such as retailing, traditional large health-related corporations, including pharmaceutical and health care companies, will increasingly enter the eHealth arena and compete or partner with or purchase smaller Internet-centric companies in the next several years.

During the last several years, federal, state, and local health agencies have been steadily increasing the variety of online health resources. Many federal agencies, particularly agencies under the U.S. Department of Health and Human Services, and nonprofit organizations sponsor eHealth-related initiatives. However, there is no federal eHealth coordinating agency or government-wide strategic plan for
eHealth, nor is there a comprehensive inventory of federally sponsored eHealth-related programs, except for a review of federal telemedicine programs. The two major federal agencies with regulatory authority over eHealth matters are the Federal Trade Commission (FTC) and the Food and Drug Administration (FDA).

Although most nonprofit health organizations were initially slow in using the Internet to further their charitable missions, many large organizations now have substantial eHealth activities and several have developed content and tools that compete with those sponsored by commercial sites. It is possible that nonprofit and public sector eHealth entities will gain market share going forward, and many nonprofit organizations, especially professional societies and universities, are continuing to develop formal partnerships with commercial companies. Nongovernmental organizations have also been playing an important role in
eHealth issues, such as research and policy analysis, quality oversight, standards development, and information dissemination.

Perspectives of Major eHealth Stakeholders

Major stakeholders with respect to eHealth development and use include consumers, application developers, clinicians, policymakers, health care organizations, public health professionals, employers, and purchasers. Understanding the various motivations and perspectives of these stakeholders is helpful in designing and implementing successful eHealth initiatives. Consumers— who may be healthy individuals, patients, caregivers, or health
professionals— are considered by many observers to be the ultimate drivers in the eHealth arena because they will ultimately decide which eHealth sites and tools will succeed or fail. The consumers' ability to drive many segments of the eHealth sector, however, will be constrained so long as the traditional decision-makers in health care spending (e.g., employers, payors, health plans) determine underlying financial incentives and the distribution of the health care dollar.

Developers of eHealth resources are an extremely heterogeneous group with differing skills and resources. In the commercial sector, the need to be ahead of the competition and financial pressures to be profitable quickly may result in released products that are not fully bug-free or have not been completely tested and evaluated. Another common dilemma for developers is finding the balance between investment in marketing and product evaluation. For many developers, the competition to obtain capital (i.e., investment funding, grants, contracts) to support development efforts may discourage meaningful collaboration with other developers, potentially resulting in inefficiencies and duplication.

Clinicians, traditionally slow adopters of information technology, have gravitated dramatically to the Internet within the last few years. Although most physicians and other clinicians now use the Internet, a much smaller fraction has actually integrated the Internet into their practice. Clinicians are not routinely applying eHealth tools in the clinical setting, probably because the Internet does not yet save them substantial amounts of time or money, and may only marginally help them provide better care. Other barriers to the adoption of eHealth tools include legal and liability issues, lack of reimbursement, and the lack of applications that can be efficiently integrated into a clinician's workflow.

Both public and private policymakers, through legislation and regulatory initiatives and through purchasing, investments, and implementation decisions, respectively, determine the context in which eHealth applications are developed and deployed. In developing legislation and regulations, public policymakers balance the uncertainties associated with voluntary industry standards and self-regulation with more direct, but often unpopular, legislative and regulatory options. Government agencies have a major role in eHealth policy given their mandate to promulgate regulations governing related areas, such as data security, consumer protection and fraud, and approval and sale of prescription drugs and medical devices. In the private sector, health care executives and large employers essentially set eHealth policy within their organizations by virtue of their purchasing and implementation decisions.

Large health care organizations, such as health plans, hospital systems, and provider groups, have been longstanding users of clinical and administrative information systems. As a result, many of these institutions have sizable capital investments in legacy systems and may be somewhat reluctant to transition to Internet-based solutions. In addition, in the current context of narrow profit margins, many health care organizations are unable or reluctant to commit substantial resources for new information technology investment. Another impediment to the adoption of eHealth tools stems from the independent operating and competitive nature of many health care organizations.

Most public health institutions have been very slow in adopting and integrating information technology into their workflow because of inadequate training, lack of public health-oriented eHealth tools, and cost considerations. Online applications that support public health functions are limited. There are essentially two major drivers that influence employer policies and decisions about implementing eHealth tools: the containment of health care costs, which often accounts for a substantial proportion of corporate expenses; and enhancing employee health and satisfaction, which may lead to greater productivity, less absenteeism, reduced staff turnover, and reduced workers' compensation claims. Typically, purchasers seek higher quality and lower costs, and many consider the Internet to be an important vehicle to achieve their goals by facilitating transactions with health plans and other vendors.

Overview of Major eHealth Issues

Quality

As in the "offline" health care industry, quality assurance and improvement are major issues for the eHealth sector. Consequences of poor quality eHealth applications include inappropriate treatment or delays in seeking appropriate health care, damage to the patient-provider relationship, and violations of privacy and confidentiality. Proposed approaches to ensuring quality of eHealth resources include accreditation, certification, rating systems, public disclosure of key information about a site or product, and posting of seals and logos indicating compliance with a set of quality standards. A number of organizations have proposed competing standards and guidelines for eHealth sites, and further consensus building or unification of approaches may reduce confusion among the public. Regardless of which approaches to voluntary quality assurance and improvement are adopted, they will need to be evaluated for effectiveness in promoting quality or changing developers' and consumers' behavior. Because current quality assurance strategies were developed for relatively static health interventions, further efforts are needed to explore new models that address the dynamic nature of eHealth technologies.

Privacy, Confidentiality, and Security

In the last few years, several widely publicized breaches of network security and global viruses have elevated the issue of online data and computer security to the center of the public eye. Although the overwhelming majority of reported security breeches do not directly involve health-related data, they foster the perception that online data of any kind are susceptible to security threats. Americans fear that personal health data will be used to limit insurance coverage or to limit job opportunities, and some of their fears about online privacy seem to be well founded. A recent analysis of the privacy policies and practices of 21 popular
eHealth sites found that most did not meet minimum fair information practices, such as providing adequate notice and giving users control over their information. Until the public is confident that health information will not be shared or sold without their consent, and that databases are secure, many types of eHealth tools, such as electronic health records, will not be widely adopted.

Under the final rules of the Health Insurance Portability and Accountability Act (HIPAA), health plans, health care clearinghouses, and health care providers who conduct certain financial and administrative transactions electronically are required to disclose how they use, store, and share health information; ensure patient access to their medical records; and obtain patient consent before releasing patient information. The extent to which the HIPAA regulations will affect eHealth companies will depend on the nature of their operations. However, because the regulations are focused on health care providers, health plans, and health care clearinghouses, it will likely only cover eHealth companies that are directly involved in those sectors, and not eHealth entities that collect personal health information in other contexts.

Access and the Digital Divide

The term "digital divide" is most often used to refer to the gap in computer and Internet access between population groups segmented by income, educational level,
race/ethnicity, age, disability, or other parameters. For example, in August 2000, households with incomes of $75,000 or higher were more than six times as likely to have Internet access than families with incomes less than $15,000. The contribution of various socioeconomic factors to the digital divide is controversial, but recent data suggests that the digital divide may be closing in some aspects. For example, although lower-income families account for a small proportion of all Web users, they represent the fastest growing segment of recent users and computer purchasers. Current efforts addressing the digital divide have largely focused on providing access to PCs, the Internet, and hardware and software training. Infrastructure access, however, is only one dimension of the digital divide, of which technology, health literacy, and appropriate content are also key elements. Despite current data showing that lower socioeconomic groups are increasingly gaining Internet access, it is likely that the digital divide will persist albeit with an evolving focus as new technologies become available. For example, as enhanced multimedia services and capability become integrated into Internet-based tools, broadband access may become as important for accessing future health care and other services as narrowband access is today for obtaining health information.

Content and Application Development

A variety of disparate individuals and entities are involved in eHealth development, and, as a result, development efforts are typically uncoordinated and essentially independent— even within the public sector. Not surprisingly, there is considerable overlap and gaps in eHealth content. Current market forces are driving rapid eHealth development in some areas, such as clinical care support, health care transactions, and business-to-business commerce. Most eHealth sites and tools, however, do not offer population health-related functions, such as population-based registries and community health tools, perhaps reflecting the perception that implementing such functionality may not translate into substantial revenue. Although new business models that support development for small markets are evolving, market demand and investors are unlikely to spur development efforts in certain neglected areas. Therefore, it is likely that targeted efforts will be needed to address the gaps in eHealth development.

Many developers have limited expertise or experience in technical or topic-specific areas that are critical for product development and evaluation. Increased information exchange and collaboration among developers, and between developers and other stakeholders (e.g., developers and users, designers and evaluators) may result in more efficient uses of special expertise and development resources and the improvement of the quality and effectiveness of resulting applications. The challenge is to foster collaborative eHealth development in the context of market competition and the desire to safeguard proprietary approaches.

Research and Evaluation

eHealth interventions have been shown to enhance social support and cognitive functioning; enhance learning efficiency; improve clinical decision-making and practice; reduce health services utilization; and lower health care costs among certain study groups. Most assessments of eHealth interventions, however, have been limited to small groups that may not be representative of the parent population, have not been randomized control trials, had limited follow-up periods, or only assessed proprietary interventions that may or may not be replicable. eHealth developers do not routinely conduct evaluations, especially post-market assessment for effectiveness. And when commercial companies and other private sector organizations do conduct evaluations, the results are often not publicly available.

Data Standards Development

Many observers believe that a vision of convergent— or at least interoperable— clinical, laboratory, and public health information systems appropriately linked to personal health information, will provide unprecedented opportunities for improving individual and population health services and knowledge. However, most current data systems are proprietary legacy systems running on various operating systems and platforms, and were conceived by dozens of different vendors. To enable universal data exchange capability, translating software is often required and data exchange standards will need to be developed.

Integration of eHealth Segments

The lack of integration and communication among the fields of health care, public health, and personal health also carry over into the online world. There is a need to integrate the various features and functions of eHealth tools, including health information and support, transaction processing, electronic health records, clinical and public health information systems, compliance and disease management programs, and behavior change and health promotion. In addition to potentially improving operational efficiencies in delivering health care and public health services, such integration promises to augment the ability of professionals to provide a seamless continuum of care. Although the Internet offers an unprecedented opportunity to integrate various health-related sectors, many longstanding political, economic, structural, and competitive barriers to collaboration and integration must still be overcome. And, with regard to information systems sponsored by public and private organizations, the lack of common data definitions and structure standards may make integration efforts unrewarding even if the political will for integration exists.

A Cautionary View of eHealth

Although the promise of applying emerging information and communication technologies to improve health and health care is substantial, it is critical that enthusiasm for this prospect be tempered with an understanding of what technology can and cannot do. In addition, some observers contend that the Internet has been over-promoted as the solution for the inefficiencies, redundancies, and quality deficiencies in the U.S. health care system. Major potential risks associated with the widespread use and adoption of eHealth tools include fraudulent online activities and poor quality resources, violations of privacy and confidentiality, unintended errors from inadequately tested or complex tools, potential misuse of applications, increasing social isolation from online activities, and widening of the socioeconomic divide.

Internet-Related Trends and Their Implications for Future eHealth Tools

Several Internet-related and other trends and technologies will have a substantial influence on the design, content, functionality, dissemination, and use of future eHealth tools. Anticipating the likely trends and technologies related to the Internet, communications infrastructure, application development, and biotechnology will help in identifying potential

opportunities for proactive investment and policy development to enhance future eHealth tools and technology.

Internet Trends

The commercialization of eHealth will continue and perhaps become even more pervasive, but noncommercial entities will likely have a role in the future eHealth market. As the Internet becomes truly global, increasing numbers of eHealth resources will be developed overseas and for global audiences. Thus, issues such as communication barriers, cross-cultural factors, and international quality assurance mechanisms will be increasingly important. As current and subsequent generations of Internet users become increasingly immersed in technology, they will likely demand immediate and constant access to information and support, and will rely heavily on online resources to inform health and other decisions. One important emerging technology is the peer-to-peer network, which allows individual computers to function as both a server and a client without any central administrator. This technology may enhance certain health activities (e.g., research, information searching), increase the availability of both credible and unsubstantiated information, and potentially threaten the Web portal model.

Communications Infrastructure Trends and Technologies

The emergence of broadband Internet service and access makes it likely that future eHealth applications will increasingly provide multimedia content, including full motion video. When traffic congestion issues on the current Internet are resolved and end-to-end quality of service is available, clinical eHealth services, such as real-time medical consultations, will be in high demand.

The current number of people worldwide with wireless Internet access is relatively small, but is expected to grow from 6 million in 2000 to 484 million by 2005. The advent of wireless Internet access is predicted to spur the growth of a new class of mobile eHealth applications for both providers and consumers. The trend toward non-PC-centric access (e.g., Personal Digital Assistants and other hand-held communication devices, Web-enabled phones, interactive TV, Web and email terminals, Internet gaming consoles) will encourage eHealth developers to cater to wider audience segments and spur development for a variety of access devices and formats.

Application Development Trends

Personalization and tailoring, with reference to interactive media, is the practice of dynamically altering content according to the profile, preferences, or usage patterns of an individual user. As personalization and tailoring become more common as components of eHealth sites and tools, increased online collection and use of potentially sensitive personal health information will raise privacy and data security issues.

Extensible Markup Language (XML), which was developed to address the shortcomings of Hypertext Markup Language (HTML), can be used to describe the meaning of content regardless of its display format. This will enable the development of innovative eHealth tools that are considerably more powerful and user-friendly than what we currently have. In addition, the growing use of Application Service Providers (ASPs) may enhance the availability of specialized eHealth tools, but may also result in privacy and data security considerations.

Biotechnology and Nanotechnology Trends

The decoding of the human genome and its subsequent biomedical advances will likely have as dramatic an impact on health and health care as the Internet will— if not more so. As the complexity and volume of genetic knowledge grow, both providers and consumers will become increasingly reliant on information technology to assist them in storing and interpreting the results of genetic testing and evaluating treatment options. As a result, new eHealth tools to support both clinician and consumer decision-making in genetics will be in great demand. In addition, nanotechnologies, such as cellular or sub-cellular sensors or computers, will generate novel methods and tools for collecting, storing, and analyzing Internet-accessible health data.

Key Questions for eHealth

Any of the previously described emerging technologies and trends is singularly powerful. Their convergence could shift basic paradigms in health and health care. Potential examples of such converging applications include wireless, sub-cellular biosensors that monitor individual health parameters in real-time; techniques for meta-analyses of genetic, biophysical, and behavioral information to inform development of personalized health interventions including therapies; and tailored, broadband, interactive multimedia health communications.

What will be the ultimate impact of emerging information and communication technologies on the future of health and health care? It is unclear how these and other upcoming technologies will evolve or how rapidly they will be integrated into health interventions and programs. Undoubtedly, as new eHealth technologies are developed and deployed, our capacity and processes to assess and make informed decisions about their appropriate use will be tested. In the near future,

several fundamental societal questions will need to be addressed. What are the policy, ethical, and legal issues around these emerging technologies? Who will have access to cutting-edge technologies? Who will pay and how much? What should be the standards and guidelines for appropriate use of these technologies? What are the implications of these technologies for health care and public health systems in terms of quality, access, and cost? Clearly, the impending availability of enhanced Internet access, innovative interactive tools and devices, integrated health information systems, and gene-based screening, diagnostic tools, and therapy, will force further public debate about the central issues of quality, privacy and confidentiality, clinical appropriateness, public policy, cost and financing, and resource distribution.

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